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THE IMPACT OF COSTS ASSOCIATED WITH NEW ENVIRONMENTAL STANDARDS UPON THE PETROLEUM REFINING INDUSTRY

PART ONE

EXECUTIVE SUMMARY

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INTRODUCTION

Changes in tastes and preferences as well as technological change frequently cause economic dislocations. We view the desire for a better environment as a change in people's preferences as to how they wish to live. Analytically this is equivalent to a change in people's preferences for certain goods or services. The workings of the market usually translate such preference changes into new and different resource allocations.

In the case of environmental controls the market mechanism is not the instrument through which economic adjustments take place. Rather, environmental controls are imposed because the national well-being requires them because there is indication that people want them. But in this case people do not have a chance to "vote" in the market place by buying or selling. Consequently those who impose the controls should have knowledge about their likely economic impact. The purpose of our study is to provide estimates about the economic impact of such controls on the petroleum refining industry.

This study is limited to assessing the economic impact of pollution abatement costs which result from regulation of petroleum refinery operations. It is aimed at determining the impact of the costs of controlling refinery airborne and waterborne emissions.

Some important pollution abatement costs which will affect the refining industry and its customers are excluded from the study. One of these is an increasing limitation on the sale of residual fuel oil containing normally occurring amounts of sulfur. Impacts of changes in the quality of the industry's products brought on by environmental considerations and changes in the supplies of materials to the industry are also excluded from the study. Some excluded matters are discussed in Section D of this Summary.

A. Principal Conclusions

We have examined the implications for the refining industry of proposed regulations for controls on refinery operations, including the requirement to use low sulfur liquid fuels. On the basis of the EPA's cost estimates we conclude:

1) Refined product prices at the refinery gate will increase about 8 cents per barrel (42 U.S. gallons) or 0.2 cents per gallon (an increase of 1 2/3 percent).

2) The earning power of the industry as a whole will be unimpaired.

3) There may be a minor acceleration in the rate at which very small refineries close.

4) Fewer than 1,000 people out of a total employment of 150,000 may be displaced.

B. Structure of the Industry

1. Industry organization

There are about 130 firms in the oil refining industry. They own some 250 refineries. Refineries are concentrated along the Mississippi-Louisiana-Texas Gulf Coast, near Los Angeles and San Francisco, in the Pacific Northwest, near Chicago, near Philadelphia, and in New Jersey, in Ohio, and in Oklahoma.

Multiple plant operations are commonplace. The 15 largest firms, each of which has over 200,000 barrels per day of total capacity, operate 105 refineries. These 105 plants account for 80 percent of the industry's capacity. Half of all refineries

process less than 25,000 barrels per day. They account for only 8 percent of industry capacity. Very few new refineries have been built in the last five years and few have been abandoned. Industry growth has primarily taken place via the expansion of existing facilities.

It is impossible to analyze the financial structure of the petroleum refining industry because too few firms, and none that are typical of the industry, are exclusively or even primarily in the refining business. Almost all firms operating refineries are also either marketers of products or producers of crude oil or both. We can assume that refining operations are, on the margin, neither more nor less profitable than the rest of a typical oil company's business. Profitability of the oil business as a whole has been subject to some variability but industry earnings have been adequate to attract capital to finance growth.

We estimate that roughly $20 billion of capital will be invested in U.S. refineries in the next ten years. Total refinery capital requirements are about 1/4 of oil companies' domestic capital expenditures. Slightly under $1 billion, or about 5 percent, of the $20 billion will be needed to conform refinery operations to environmental standards.

The market for wholesale oil products is competitive. That is, the price elasticity of demand facing individual firms is high. Despite a strong and continuing industry effort to establish brand differentiation for retail consumers, the wholesale market operates on a commodity basis. Prices on the various unbranded markets typically are close to short-run marginal costs which may be higher or lower than average costs, including capital charges, depending on refinery utilization rates.

There currently are about 150,000 employees in refining. Despite recent industry growth employment has been essentially stable. About 2/3 of these employees work in refineries, the balance in laboratories or central offices. Of the employees actually working in refineries about 35,000 are skilled workers who are specialized to the industry. Hourly earnings in 1971 in petroleum refining are estimated at $4.82 versus $3.58 for all manufacturing.

2. Markets and Products

Well over half of total refinery output is sold through distribution and marketing facilities which refining companies own or in which they have a financial interest. But considerable product is sold by refiners directly to customers.

The industry manufactures hundreds of different products which may be grouped into four broad product classes: gasoline, intermediates, residual, and other.

Gasoline accounts for about 45 percent of industry output, about one half of the value of output, and is typically priced at about 12 cents per gallon in cargo lots on the Gulf Coast. Consumption and production have increased about 4.7% per year.

Intermediates include jet fuel, kerosene, space heating oil, and diesel fuel. These products are typically priced at about 10 cents per gallon and make up about 33 percent of industry output. Consumption and production have increased about 5.2% per year.

Residual is currently priced at from about 6 cents to about 12 cents per gallon or even more, depending on sulfur content and location. Residual amounts to about 6 percent of domestic

petroleum production and 17 percent of domestic consumption of all oil products. The difference is accounted for by imports. U.S. production has been about stable and consumption has increased about 3.5 percent per year.

Other products include asphalt, lubricants, liquefied petroleum gas (mostly propane), naphthas and solvents, coke, petrochemicals and petrochemical feedstocks. These products account for about 16 percent of the domestic industry's output. They are priced from 4 cents to $1.00 per gallon.

As a result of a quota-based limit on imports foreign competition is essentially non-existent except in the case of residual oil sold primarily on the Eastern seaboard. Prices of this product are determined by supply and demand on the international market.

The industry's primary products - gasoline, turbine fuel and the transportation fuel part of the intermediates market - are not subject to significant inter-industry competition. Natural gas competes with the heating oil portion of the intermediates market in many parts of the country. Natural gas and coal compete for a portion of the residual oil market.

Oil product prices have increased at a slower rate than either consumer or wholesale price indices, largely because the industry has been able to utilize improved technology to offset cost increases.

3. The Refining Process

Notable features of refinery operation include extensive use of capital equipment, relatively low manpower requirements,

high water requirements, and high energy consumption (about 12 percent of crude intake or its equivalent).

Crude oil is the primary raw material used in refining. Crude oils are liquid mixtures of many carbon-containing chemical compounds. In refining, crude oil is first separated into several groups of varying molecular size known as cuts. The chemical composition of some of these cuts is then altered by changing the average molecular size. Some cuts are further processed to alter the shape or structure of the molecules. Most of the original and the altered cuts are "treated" to make innocuous or to remove impurities, notably sulfur. Treated cuts are then blended to produce finished products. To these may be added substances known as additives to improve performance of the blended products.

In refining operations polluting materials are generated and released into the environment if not controlled. For this study the EPA defined technological solutions to control some of the emissions of these pollutants as follows:

1. Sulfur compounds in refinery fuel gases will be removed.

2. Tanks containing gasoline or volatile crude oil will be equipped with floating roofs.

3. Larger catalytic cracking units will be equipped with electrical precipitators and with carbon monoxide boilers.

4. Refinery waste water will be skimmed, neutralized, settled and subjected to biological treatment.

But one pollution source omitted in the original study scope, sulfur oxide emissions from burning sulfur-containing liquid fuels in refineries, has important cost and price consequences.

After discussions with EPA it was agreed to include the cost of substituting low sulfur oil for high sulfur fuel as an operating cost. (See Section D below.)

C. Impact of Pollution Controls

The Environmental Protection Agency has estimated that $845 million of capital (range: $634 million to $1,155 million) will be required to conform refineries to new standards. Of this amount $732 million are required for modifying existing facilities and $113 million for refining facilities to be built in the period 1972 through 1976. Operating costs of $2 million in 1972 rising to $21 million in 1976 will be incurred to operate and maintain this equipment. Substitution of low sulfur liquid refinery fuels for currently used liquid fuels will cost about $108 million annually by 1976.

The question we attempt to answer is: Who will pay these new costs, and how important will they be to the industry as a whole, to some parts of it, and to the U.S. economy generally?

1. Effect of control costs on industry costs and on prices.

Due to import controls the products of the petroleum refining industry (except residual oil) are not significantly subject to foreign competition. Furthermore, of the major products, only residual and intermediates used for space heating face competition from products of domestic industry, specifically from coal and natural gas. And due to the nature of the market for crude oil it is unlikely that the new control costs in petroleum refining can be passed back to crude oil producers. Consequently these

cost increases will be passed on to the industry's customers or absorbed by refiners. For the reasons discussed below it is unlikely that such an absorption will take place by the industry as a whole.

The increased costs are of two kinds: capital costs, required to pay for control equipment, and operating costs. The capital will be used to conform existing facilities and to conform facilities built to supply the growing demand for industry products. The operating expenses also are of two kinds: those associated with operating and maintaining the new equipment, and the costs of replacing currently used liquid refinery fuel with low sulfur liquid fuel.

The combined impact of these new costs will be an 8 cents per barrel (0.2 cents/gal) price increase. We have arrived at this estimated price increase as follows: Industry prices will have to increase about 1 3/4 cents per barrel (about 1/3% of the refinery gate value of products) more than they otherwise would in order to attract the $113 million capital required to install control equipment in new facilities. This is the price increase required for an 8 percent return on new capital to prevail. We have used this cost of capital (with one minor exception) throughout our study.

This price increase of 1 3/4 cents per barrel will also be adequate for the industry to recover, at 8 percent, about $604 million of the $732 million required to conform existing facilities to new standards. The balance, $128 million, is unrecoverable and the recovery of the $604 million will not begin until substantial new facilities are built.

In addition to the 1 3/4 cents per barrel price increase there will be a further rise in price of less than 1/2 cent per barrel to cover the cost of operating control equipment installed in refineries. In this case, as in that just discussed, the price increase will be required to justify industry expansion.

The economic impact of the substitution of low sulfur liquid refinery fuels for the currently used liquid fuels will cause a 5 3/4 cent per barrel price increase and also an increase in industry cash income. The economic rationale for this is somewhat complicated. Liquid refinery fuels are the highest cost refinery fuels used. They determine the industry's marginal costs and hence refinery gate product prices. When low sulfur fuel usage becomes mandatory refinery marginal costs and hence prices will rise by about 5 3/4 cents per barrel (assuming the EPA estimate of a 90 cents per barrel cost differential between high and low sulfur liquid fuel). But average refining costs will rise by considerably less because most other refinery fuel costs will be unaffected. As a result there will be an after tax increase in cash income of about $86 million per year. Even if only a small part of this $86 million per year is actually realized it will be more than adequate to compensate for the unrecoverable $128 million in capital mentioned above.

The above are impacts on industry costs and on prices. The impact of costs on individual refineries may differ considerably and is discussed next.

2. Control Cost Differences among Refineries

a) Large refineries

The economies of scale in the installation of control

equipment considerably favor large refineries. Hence no large refinery operations are likely to be discontinued as a result of the costs of meeting environmental standards.

b) Small refineries

The median size refinery has a crude oil processing capacity of about 25,000 barrels per day. All refineries of median size or smaller account for only 8 percent of the industry's capacity. Because of the large difference in per-barrel control costs occasioned by size and also because per-barrel control costs vary considerably with process equipment installed, and consequently products made, we attempted to investigate the differing impacts upon several classes of small refineries. [This is not possible to do quantitatively because no published data on product volumes, profitability, cash flows or net worth of such plants exist.]

On the basis of our analysis we judge that there may be an acceleration in the closing of small plants from a recent rate of about three per year to a rate of about five per year. Very few new small plants have been built recently. Our estimate of the number that may close is subject to a great deal of uncertainty. The actual number, if any, will be considerably influenced by small refineries' ability to avoid some of the costs included in the EPA's estimates. If they can share the cost of operating water treatment facilities, for example, with their municipality, or if they can secure some relief in the proposed sulfur removal equipment requirement, then their ability to bear the additional costs will be much increased. Otherwise they will face costs per barrel two to three times greater than those of large refineries. If the EPA's high range cost estimate applies, rather than the mean estimate we used, the cost disadvantage of small plants would be increased.

Our view is that if control costs lie near the mean EPA estimate perhaps a dozen small refineries may close during the period 1972-1976 in addition to the 15 or so that historically would be expected to close for unrelated reasons. Twelve small refineries probably employ less than 1000 people and have a total capacity of less than 100,000 barrels per day. Both of these values are about 0.7 percent of industry total. The closings might double if the high range of control cost estimates applies. But the closing rate is less sensitive to lower costs.

Plant closings are most likely to occur in areas where no refinery construction or expansion is now taking place. Consequently re-employment is likely to depend on employment opportunities in other industries in the areas of the closed plants or on relocation. The refineries most likely to close are for the most part located outside major metropolitan areas.

D. Related Issues

1. Sulfur emission limitations

In this report we deal with the economic effects of sulfur emission controls only to a limited extent because we have been concerned only with control of emissions from refinery operations. Our consideration was further restricted by the assumption that desulfurizing of refinery liquid fuels will cost only 90 cents per barrel during the period 1972-1976. This assumption may not be useful.[1)]

The following comments are directed to the general issue of limiting sulfur oxide emissions from all U.S. users who burn residual fuel oil.

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1) Current Gulf Coast cargo prices (High sulfur $2.00 per barrel (Maximum 0.5 percent sulfur $3.70-$3.80 per barrel (Platt's Oilgram Price Service, October 28, 1971)

No commercial facilities now exist in the U.S. to reduce the sulfur content of residual oil. Residual oil currently consumed in the U.S. varies in sulfur content from about 0.3 percent to as high as 4 percent. As increasingly stringent sulfur emission limitations have been imposed in various localities the price differential between high and low sulfur oil has widened reflecting the scarcity of low sulfur material. Currently the price differential is double or triple the 90 cents per barrel estimated by EPA to be the long term expected differential.

Sulfur oxide emissions from burning residual fuel oil can be controlled either at the time of combustion or by desulfurizing the fuel. Both control methods will eventually be used and in time the price differential between high and low sulfur residual will sink to the level which properly reflects the long run costs of desulfurizing. But the short run price differential will probably be higher than the long run cost difference contrary to what has been assumed in this (and related) studies. This effect will be amplified if stringent sulfur emission limitations are imposed more quickly than desulfurizing facilities are built. Consequently, the cost to residual-burning industries to conform to environmental standards in the next few years may be considerably greater than these studies suggest.

A price which reflects short term scarcity rather than long term economic costs will impose costs on fuel users which do not bring any apparent offsetting benefits. This would happen if, as we believe, the supply of low sulfur residual is price inelastic in the short run.

Also a scarcity-determined price would tend to benefit, beyond the long term value of their facilities or oil, producers

of low sulfur crude oil abroad (or their host countries)[1] as well as those foreign refineries which now have desulfurizing facilities. At the same time the short term competitive position of producers of high sulfur residual oil would be impaired even though their oil eventually could be sold to users who will install stack gas scrubbing equipment.

Currently about 600 million barrels of residual fuel oil are imported annually at a cost of over $2 billion. Roughly 300 million barrels per year are manufactured in the U.S. Under current import regulations, which restrict importation of crude but not of residual, no incentives exist to construct desulfurizing facilities in the U.S. In fact more stringent sulfur emission regulations might result in a reduction of domestic manufacture of residual oil (the cost of manufacturing low sulfur residual, which must compete with foreign product, is close to the cost of manufacturing gasoline, which is protected from foreign competition).

An optimal implementation of sulfur emission limitations, whether by regulation or by emissions tax, is one which leads to the fastest economic construction of desulfurizing facilities and a price of low sulfur oil sufficient to insure maximum practicable distribution of this product in the U.S., but not so high as to impose undue burdens on its purchasers. We note again that current import regulations appear to encourage construction of desulfurizing facilities outside of the U.S. This fact may raise policy questions which are unrelated to environmental considerations.

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1) Although much of the crude oil discovered during the past decade has a rather low sulfur content the residual fuel manufactured from it typically contains more sulfur than will be permitted to be burned without further desulfurizing. Moreover, marginal crude oil supplies are high sulfur. Consequently the price of low sulfur crude oil includes a "premium" which reflects the market value of its low sulfur content.

2. Natural gas use

Pipeline quality natural gas is the least environmentally damaging fuel available in large quantities. It is also the cheapest fuel available in many areas. The supply of gas is not growing nearly as fast as the demand for it and there should be an optimal way of allocating the available gas to maximize environmental and economic considerations.

Many industrial plants, such as utilities, refineries and manufacturing companies, now burn natural gas. If they have to switch to another fuel, because of inadequate supply of gas, they will incur substantial cost increases. A change to low sulfur liquid fuel would impose still higher costs. Thus, they would incur substantially higher costs and, at the same time, present a greater pollution problem to the extent that they must give up gas.

Changing existing space heating from low sulfur home heating oil to natural gas, on the other hand, brings no important environmental benefits. Therefore it does not seem desirable to limit gas consumption by high volume users in order to increase supplies available for space heating.

In studying this matter the alternative ways of meeting environmental goals should be explicitly considered together with the costs of natural gas production and marketing.